Ex Vivo 7T MRI & Radiomic Feature Analysis for Prediction of Frontotemporal Lobar Degeneration Gray Matter Pathology

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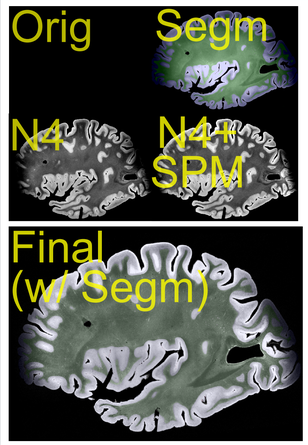
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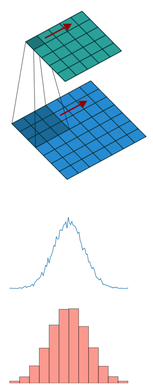
BACKGROUND

- ***Ex vivo T2*w MRI links directly to gold standard neurobiological changes***[1]
  - Much **higher resolution** compared to in vivo MRI
  - Validate via **gold standard histopathology** to MRI
  - Possible clinical translation to in vivo MRI
- ***Ex vivo T2*w MRI identifies whole brain degeneration***
  - Iron degeneration has high signal to noise
  - Drives full brain understanding of microstructural changes
- ***FTLD neuropathologic heterogeneity remains difficult to quantify***
  - Gross measures of volume change may miss **finer microstructure changes**
  - Biomarkers for **pathology localization** can inform further studies

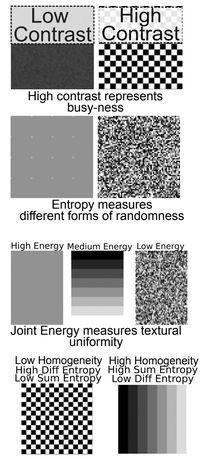
METHODS



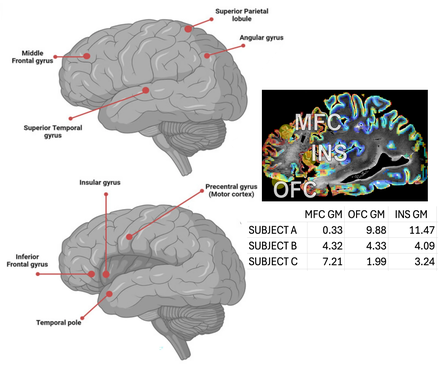
GM Segmentation and Intensity Inhomogeneity Correction to normalize intensities



Compute local GM radiomics by independently discretizing each sliding window of brain

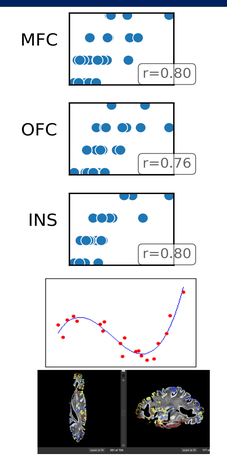


Features correspond to *human interpretable textures*



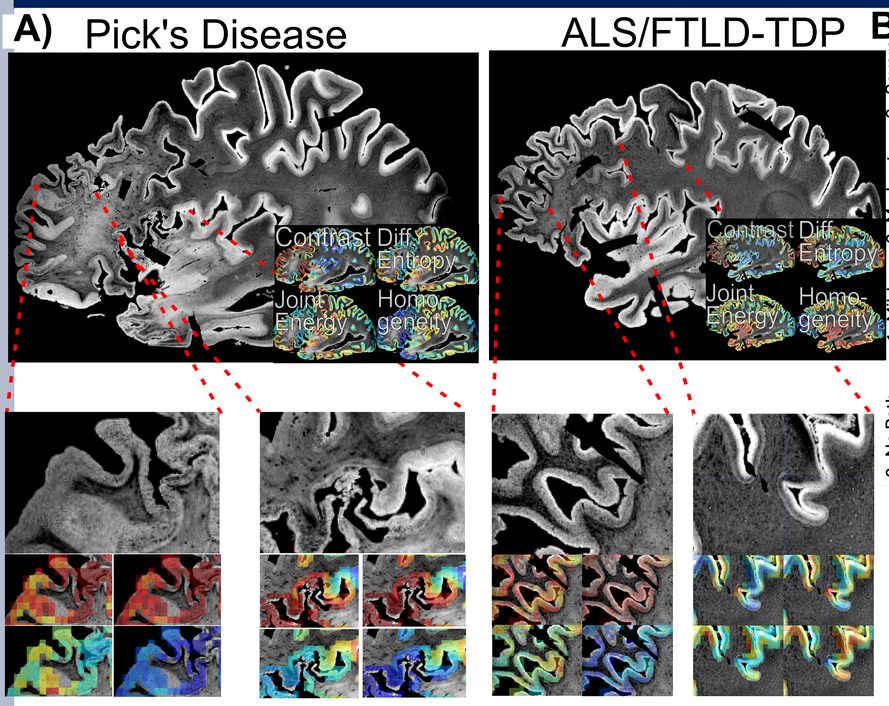
	MFC GM	OFC GM	INS GM
SUBJECT A	0.33	9.88	11.47
SUBJECT B	4.32	4.33	4.09
SUBJECT C	7.21	1.99	3.24

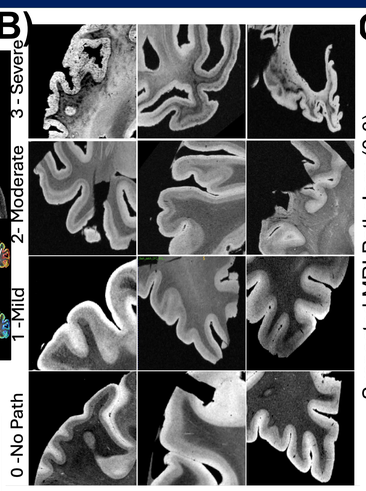
Regions are rated[2] and radiomic features extraced within 25mm of neuroanatomical location

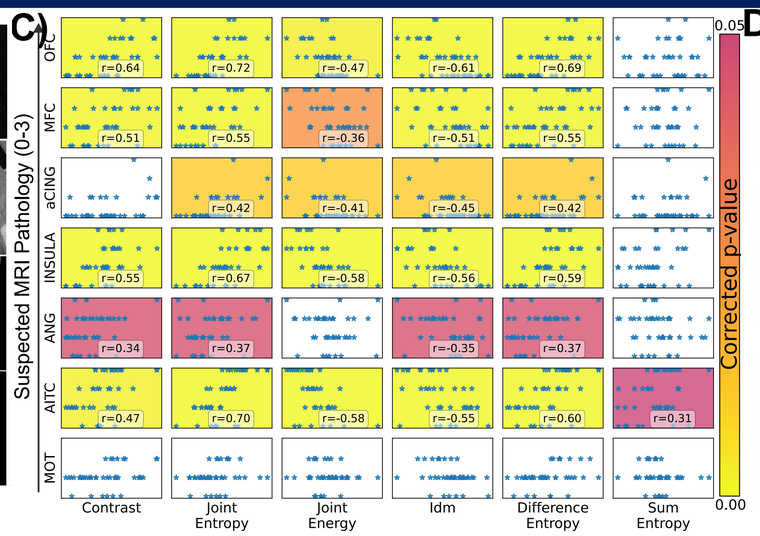


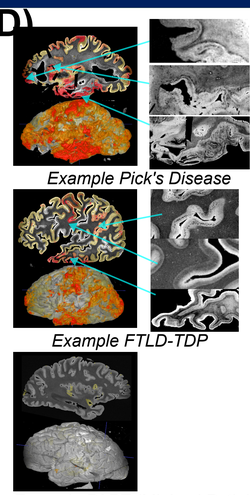
Spearman Correlation and multivariate models validate radiomic measures

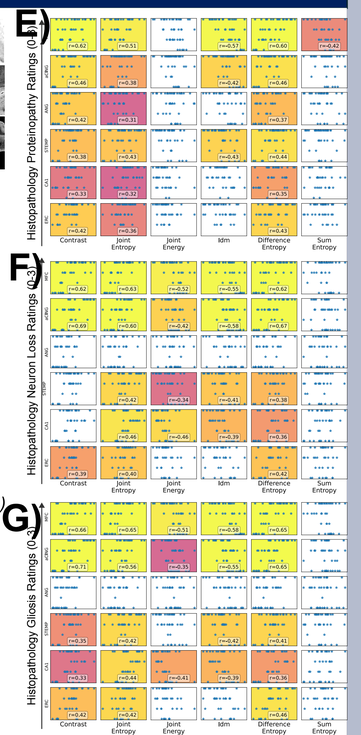
RESULTS











A) Radiomic feature maps show differential values corresponding to qualitative texture features. B) Example MRI suspect pathology regions and ratings by expert. C) Radiomic features Spearman rank correlation against ratings. D) Fitted Ordinal Regression model with radiomic features reproduces expected patterns of pathology. E) Contralateral hemisphere correlation against ratings of histopathology disease (maximum of Tau/TDP-43 pathology ratings) shows many features are significant. F) Contralateral histopathology gliosis ratings correlate to radiomic features. G) Contralateral histopathology neuron loss ratings correlate to radiomic features.

CONCLUSION

- MRI is **rich source of textural info**, but intensity values usually have no inherent unit
- Histology is **ground truth** of neuropathology and cellular degeneration but has **limited spatial extant**
- Whole-brain radiomic maps **links histology microscale to whole-hemisphere macroscale**
- Pipeline with per-window discretization and heavy intensity inhomogeneity correction can create useful texture features
- Analysis identifies disparate texture features that correlate with expert suspect pathology ratings and ground truth histopathology
- Automated analysis can output focal locations of clusters of suspected pathology

Future Directions

- Beam search across whole brain for anomaly detection and hierarchical analysis
  - Spatial clusters can be digitally biopsied to further interrogate biological processes
- Group comparison of radiomic features and anomaly prediction maps
- Additional improvement and refinement of features
  - Accounting for cortical geometry with angle-specific measures
  - Deep embeddings trained on radiomic feature maps

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2. Emrani, S., Teunissen-Bermeo, E., Trotman, W., Bahena, A., Capp, N., Ohm, D.T., Das, S.R., Wolk, D.A., Lee, E.B., McMillan, C.T., Gee, J.C., Yushkevich, P.A., Tisdall, M.D., Irwin, D.J., n.d. Ultra-high resolution 7T T2*w ex vivo MRI patterns differentiate underlying FTLD pathology in behavioral variant FTD. https://doi.org/10.1002/alz70861_108813

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